STUDIES ON THE EFFICIENCY OF OYSTER SHELL AND KAOLIN AS ADSORBENTS FOR BLEACHING OF PALM OIL

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Abstract

In this study, acid activation and characteristic studies were conducted for oyster shell and kaolin. The bleaching efficiency of the activated adsorbent samples for palm oil were determined. The activation was carried out at three different acid concentration (1M, 3M, 5M) with H_2SO_4 and HCl.both samples showed strong improvement on the colour of palm oil with their R^2 factors higher than 0.999 but kaolin and treated with HCl have the higher percentage colour reduction of 96.53 while kaolin treated with H_2SO_4 has 96.22 compare with oyster shell treated with HCl and H_2SO_4.

Acid activated clays are the most common agents for bleaching of vegetable oils. Among them are activated bentonites, activated carbon, synthetic silicates etc. the clays remove materials such as chlorophyll, carotenoids, phospholipids, metals, and oxidation products from oils. So far, the removal of these constituents has been explained only in terms of adsorption (Kheok and Lim, 1982; Taylor, 1989).

In many countries', the major edible oils traditionally are consumed in a clean but unrefined form. These oils are unaltered and any materials naturally present remain in the product (Mounts, .1981). Bleaching is designed solely to remove pigments like carotenoids, oxidation products, trace metals and trace soaps from the oil. Adsorptive bleaching is the most efficient form of bleaching in which various adsorbents are used. The amount of adsorbent required for any given bleaching operation will depend on the nature and activity of the adsorbent, the variety of oil, and the colour of the oil to be used (Purvis, .1975; Young, 1981).

Adsorptive bleaching using activated clay is based on the ability of these clays to preferentially concentrate specific substances(impurities) from solutions unto their surfaces, after activation treatment has been done on the clay material(Treybal, 1982).

The widely used bleaching earths are bentonite and fuller's earth. Studies showed that much work has not been reported about oyster shell and its potential for the bleaching of oils, as this has not been fully exploited. Therefore, the objective of this work is to investigate and evaluate the potential of oyster shell and kaolin in bleaching of palm oil.

Materials and Methods

Oystershell was obtained from Warri in Delta State while Kaolin was obtained from Okpella (Edo State). The crude palm oil was obtained locally from Warrake market. Sulphuric acid and hydrochloric acid used were of analytical grade. Thepercentages chemical composition of the shells and kaolin were given in Table 1

Preparation of Samples

The oyster shell (OS) and kaolin (K) were washed with hot water, and then rinsed with distilled water and sun dried for several hours. The sun dried shell and kaolin were crushed, ground to powder form. The oyster shell (OS), andkaolin (K) were sieve using 100 micron mesh size which were used in activation process.

Acid Activation

The samples were treated with H_2SO_4 and HCl solutions at concentrations of 1M, 3M, 5M and acid/clay ratio of 0.4. 100ml of H_2SO_4 was added to 250g sample suspended in water. The mixture was maintained at a temperature of 100^OC for 30 minutes. The resulting mixture was filtered washed with hot distilled water and dried in an electric oven at 105^0C.

Bleaching Process

The bleaching process was carried out by adding 100g of degummed oil and 2g of activated samples into a Pyrex glass (250ml) and heated at constant temperature of 90°C on a hot thermostatically controlled electric plate with stirrer for 30minutes. The mixture was filtered to separate the bleached oil from the bleaching sample.

Analysis of Bleaching Performance

The absorbance of unbleached (crude) palm oil and bleached palm oil was measured using a UV-VIS Spectrophotometer. Bleaching efficiency was evaluated by monitoring the absorbance at 450nm as given by the following formula.

$X = A_o - A_t/A_o$ where X is the relative amount of pigment adsorbed, A_o is the absorbance of unbleached oil, A_t, is the absorbance of bleached oil at time t.

$X_e = A_t/A_o = 1\text{-}X$ where X_e is the residual relative amount at equilibrium.

Table 1. % Chemical Composition of the Samples

	SIO_2	Al_2O_3	Fe_2O_3	Na_2O	CaO	K_2O	MgO
Oyster shell	44.4	9.2	0.08	0.59	45.0	0.05	0.44
Kaolin	78	4.8	4.3	0.42	10.8	0.65	1.0

Results and Discussions

The absorbance of unbleached (crude) palm oil is 3.390at 450nm and the values of absorbance are given in table 2 and 3 at different acid concentrations. The bleaching efficiency increases as the concentration increases, since the absorbance decreases as the acid concentration increase; it shows that the relative amount of pigment adsorbed increases while the residual relative amount at equilibrium decreases for the bleaching of palm oil.

Absorbance (H_2SO_4)

Conc (M)	oyster shell	kaolin
1	0.345	0.140
3	0.265	0.133
5	0.255	0.128

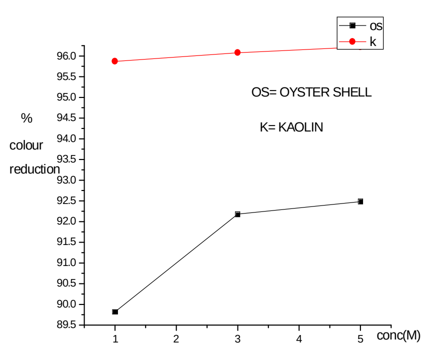
Table 2

Absorbance (HCl)

Conc (M)	oyster shell	kaolin
1	0.255	0.143
3	0.250	0.138
5	0.215	0.118

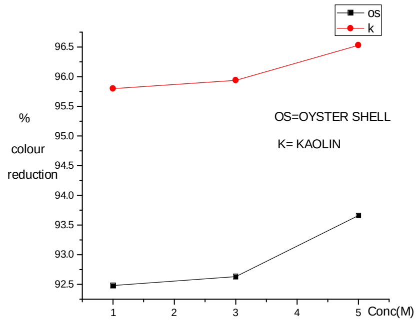
Table 3

The oyster shell and kaolin samples were activated with H_2SO_4 and HCl at three acid concentrations (1M, 3M,5M). The percentage colour reductions are shown in fig 1 and 2; where percentage colour reduction was plotted against acid concentrations. Generally, percentage colour reduction increases as acid concentration increases



Graph of oyster shell and kaolin activated with sulphuric acid

FIG 1



Graph of oyster shell and kaolin activated with hydrochloric acid
FIG 2

Figure 1 and 2 showed that kaolin activated with HCl and H_2SO_4have greater bleaching efficiency than the shell treated with $H_2SO_4$and HCl. Highest percentage colour reduction of 96.53 was achieved in kaolintreated with HCl while 96.22 was achieved with H_2SO_4. Also, maximum percentage colour of 93.66 was observed with oyster shell treated with HCl against 92.48 observed when H_2SO_4 was used. This might be as a result of high solubility of the chlorides of Mg, Ca, and Fe than that of the sulphates of the same metals. (Proctor and Palaniappan (1989) and Brace (1973). Attributed the high adsorptive efficiency of HCltreated clays to the complete removal of Al, Mg, and Ca ions within the crystal of the clay. It can therefore be inferred that impurities such as Fe_2O_3, CaO, and MgO etc. are removed during activation process.

The effectiveness of the oyster shell and kaolin was further investigated using the concept of Freundlich adsorption isotherm. $X/m = KX_e^n$…………. (1)

Taking logarithm on both sides of equation (1). $Log(x/m) = logK + nlogX_e$; where K and n are Freundlich constants.

	Oyster shell			kaolin		
	n	k	R^2	n	k	R^2
H_2SO_4	-0.0995	0.8365	0.99916	-0.0413	1.1221	0.99984
HCl	-0.0741	0.9314	0.99983	-0.0395	1.1373	0.99958

Table 4 Table 5

Freudlich equation is valid for any method of colour measurement, as the units of measurement are additives and proportional to the actual concentration of colouringmaterials in the oil (Hui, 1996). The value of n and k (Freudlich adsorption constant) calculated table 4 and 5 using equation (1) Showed that kaolin treated with HCl is most effective followed by kaolin treated with H_2SO_4, then oyster shell treated with HCl, and finally oyster shell treated with H_2SO_4.The high values of k recorded is an indication of this, since k is a general measure of the activity or decolourisation power of the adsorbent, where n is an indication of its characteristic manner of adsorption (Noris, 1982). The higher valuefor k indicates higher adsorption capacity for oil. The R^2 values were all higher than 0.99, indicating a very good mathematical fit.

Conclusion

In this study, oyster shell and kaolin were used as adsorbents for bleaching of palm oil. Acid activated oyster shell and kaolin showed effective bleaching as the acid concentration increases but kaolin treated with HCl showed higher bleaching efficiency. However, both gave improvement on the colour of palm oil indicating high level of good adsorbents for the bleaching of palm oil.

Recommendation

Both oyster shell and kaolin showed greater performance in the bleaching of palm oil therefore, they are recommended to aid further reduction in cost of imported and expensive bleaching agent (bentonite) since they are locally available.

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